Precision Measurement of μp Capture in Hydrogen - the μCAP experiment

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The induced pseudoscalar coupling constant g_p has been poorly known for decades, despite its fundamental contribution to hadronic weak interactions. Recent disagreement between experimental results and the predictions of modern low-energy QCD effective field theories – which have already reached a precision far beyond experiment – calls for a precision determination of g_p.

The rate Λ_s for muon capture on the proton from the 1s-singlet state is directly related to g_p. The goal of the μCAP experiment is the high-precision measurement ($\pm$ 1 %) of Λ_s by comparing the muon lifetime in the μ^-p system with the lifetime of free μ^+.

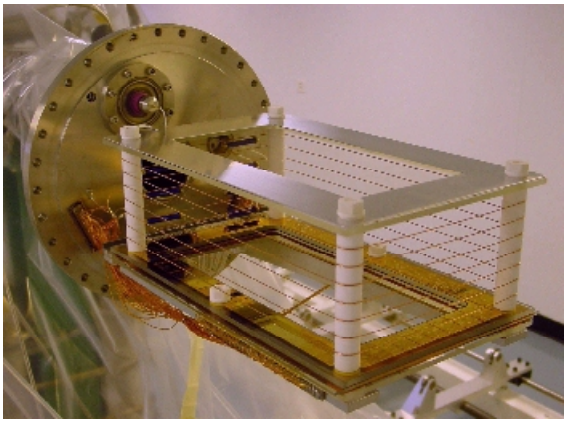

Figure 1: View of the TPC mounted on the back flange of the hydrogen pressure vessel.

The experimental apparatus has been developed and tested recently, and last year the central detector, the time projection chamber (TPC), was finished (Fig.1). The TPC serves as an ultrapure hydrogen target: the final goals are a $Z > 1$ contamination lower than 0.01 ppm, and a deuterium content of less than 0.3 ppm. This guarantees the control of otherwise large systematic effects.

Running the TPC with a 2 kV/cm drift field (6.5 kV total) enables us to observe the path and stopping position of the muons and minimum ionizing particles, i.e. the muon decay electrons.

We have successfully tested a Berkeley-made magnet, which is used for the determination and control of the muon spin rotation of the μ^+ due to residual beam polarization.

A high-throughput DAQ system with real-time data compression necessary for the extremely high precision and statistic of the experiment is being developed at Berkeley.

Fig.2 shows the scintillation hodoscope detector which measures the time of the decay electron/positron with respect to the incoming muon. Inside are two electron wire chambers used for tracking the decay electron to its parent muon.

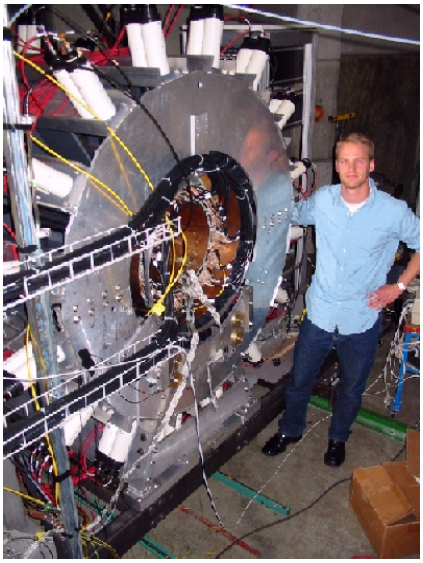

Figure 2: The experimental setup: scintillator hodoscope, electron wire chambers; and Berkeley grad student Tom Banks.

Having completed a successful commissioning run, we have scheduled a final assembly and first production data taking for 2003.

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